Nonproliferation, Arms Control, and International Security

Preventing, responding to, and reversing nuclear proliferation are top priorities for national and global security. We are providing multidisciplinary expertise, response and advisory personnel, and cost-effective technologies to help reduce the danger from foreign nuclear threats and other weapons of mass destruction.

The detection, control, and monitoring of nuclear weapons and materials plus the response to proliferation threats have become leading challenges for the national security laboratories. To meet the challenges, we refocused and enlarged our nonproliferation efforts two years ago into a new directorate called Nonproliferation, Arms Control, and International Security (NAI). We are concentrating on six areas within a mission that emphasizes the Laboratory's special nuclear weapons expertise and responsibilities. Activities in these six areas include:

- Developing sensors, platforms, and analysis techniques that can detect and characterize signatures of nuclear weapons programs and help verify international arms control agreements.
- Providing intelligence-based assessments to the U.S. government of clandestine and acknowledged nuclear weapons activities worldwide.
- Providing expertise and technology for the U.S. government to establish dismantlement, tracking, and transparency regimes for nuclear weapons and fissile material, and assisting in efforts to control fissile materials worldwide.
- Providing support for arms control policy makers.
- Developing technology that can find and neutralize battlefield and terrorist nuclear weapons.
- Assessing the impact of possible counterproliferation systems and strategies through computer-based conflict simulation and comprehensive systems analyses.

In addition, we support U.S. efforts to reduce the danger from other weapons of mass destruction, and we make our capabilities available to support other emerging defense and civilian needs. To ensure a strong and coordinated DOE program, we work closely with Los Alamos, Sandia, other DOE national laboratories, and other U.S. government departments.

In early 1993, the DOE's three national security laboratories joined forces in areas related to most of the six NAI program areas. Since then, we have made considerable progress, particularly in planning for sensor research and development, which is the area of largest funding and where it is most important to identify savings. In early 1994, the DOE and Department of Defense (DOD) began planning in the area of counterproliferation. With respect to Russian interactions, the laboratories have been working closely with the DOE and DOD and are now increasing efforts with strong support by the State Department.

We developed a portable chemical-analysis instrument to accurately analyze samples at an inspection site, a key issue related to the Chemical Weapons Convention. The latest generation of this instrument is contained in a small suitcase and weighs only 23 kg (~50 lb).

Sensor Development

The DOE Office of Research and Development has tasked the national laboratories with developing remote sensors that can detect signs of an existing or emerging capability to produce weapons of mass destruction. In response, we are developing several new remote detection systems, most of which are in early stages, and other systems for onsite applications, some of which are complete.

Monitoring in Iraq

The United Nations Special Commission is tasked with implementing the international agreements that require monitoring specific activities and facilities within Iraq. In 1994, the Laboratory demonstrated its fast-response engineering and fabrication capability by providing equipment for monitoring several sites in Iraq. LLNL designed, procured, fabricated, and tested 12 tons of equipment over a six-week period beginning in May 1994, with delivery to Iraq on June 30, 1994. The equipment included

16 self-contained monitoring stations with multiple sensors and onboard, uninterruptible power systems interconnected through a microwave telephone system.

Forensic Science Center

A key element of our onsite inspection capability is our Forensic Science Center, which we have brought to nearly full operating capability. The center uses various sample analyses to identify minute quantities of materials related to nonproliferation, counterterrorism, law enforcement, narcotics, and environmental protection activities. Analyses of chemicals in water, air, soil, and vegetation can be used to confirm suspected weapons activities and to support various international verification agreements.

Portable Chemistry Laboratories

A key to Chemical Weapons Convention verification is the ability to analyze samples precisely at an inspection site. We have now demonstrated the ability to transport a self-sufficient chemistry laboratory to an inspection site, to collect a variety of samples, and to analyze them with the same results as would be obtained in a large analytical laboratory.

We also turned over to industry a suitcase-size instrument that can analyze samples extracted from swipes, soil, and water using chemical solvents and solid-phase extraction techniques. This instrument includes a lightweight gas chromatograph and mass spectrometer. Its long operational lifetime and portability should also make it a useful tool for emergency-response personnel trying to identify an unknown chemical spill and for firefighters in identifying potentially hazardous emissions from warehouse fires. A possible follow-on instrument could be about half the size of the existing one.

Unattended Ground Sensors

In 1992, over 95,000 apprehensions were directly based on alerts from the Border Patrol's unattended ground sensor network, making it one of the most effective counterdrug tools available. Our new generation of modular, unattended ground sensor systems—called INSENS, for Immigration and Naturalization Service Sensor System—can be linked into existing systems of the Immigration and Naturalization Service. The system uses seismic, magnetic, and passive infrared detectors, and future plans include incorporating hydrophones and imaging systems into the system. Full-scale production of the INSENS system is slated for 1995. The open architecture we developed for INSENS is now being adapted for use by the DOE to support nonproliferation programs.

Intelligence Assessments

Laboratory people have assessed nuclear proliferation problems on every continent except Antarctica and Australia. Our support to the U.S. government has grown as nuclear proliferation issues increasingly become complex mixtures of international obligations, regional security concerns, and safeguards technology. Specialists in the nuclear fuel cycle, engineers, regional experts,

Highlights for 1994

- Designed, fabricated, tested, and delivered 12 tons of equipment to help monitor activities and facilities in Iraq.
- Turned over to industry a suitcase-size portable chemical-analysis instrument that can analyze field samples without the delay of returning samples to a fixed site.
- Developed a new, cost-effective information management system, Watson, for use by nonproliferation specialists.
- Expanded our interactions with the New Independent States to support more than 150 collaborations ranging from nonproliferation research to basic science.
- Provided the science advisor to the DOE CTB delegation at the Conference on Disarmament.
- Delivered Lab-developed emergency-response equipment and software to assist two former Soviet republics.
- Advised the U.S. government on the credibility of sales offers and implications of illicit sales of nuclear materials worldwide.
- Pursued several new applications for projects in our Conflict Simulation Laboratory, including assistance in planning operations in Bosnia and Somalia.
- Developed the Virtual Commander—a large-scale, high-resolution computer simulation tool—to model complex tasks with minimal human input.

Watson is a new information management system used to analyze proliferation activites. On the computer screen is an example of the geographic viewer. Given a place name, it can retrieve geographic data (such as maps and satellite images) that contain the place in question. Conversely, if a geographic region is being viewed, it is easy to obtain text documents that refer to place names in that region.

country specialists, and political scientists have been called upon individually and in teams to support U.S. and international efforts to maintain and strengthen the international norms against the spread of nuclear weapons.

North Korea

Recent tensions over North Korea's disagreements with the International Atomic Energy Agency demonstrate the importance of clear and transparent nonproliferation commitments. They also highlight the importance of the technical details of safeguards on nuclear reactors, nuclear fuel reprocessing plants, and separated plutonium. North Korea's fiery rhetoric and the influence that failure to resolve the North Korean dispute could have on other countries combined to make dramatic headlines. Behind the headlines, Laboratory people provided technical support for wide-ranging U.S. efforts to engage North Korea in productive dialog and convince them to fully open their nuclear program to meet their obligations under the Nuclear Non-Proliferation Treaty.

Nuclear Materials Tracking and Process Simulation

The control and use of nuclear materials—particularly highly enriched uranium and plutonium—are the focus of concern in countries ranging from the former Soviet Union to North Korea and from Iraq to South Africa. Concern also exists about the shipment, use, and disposition of power-reactor plutonium in Japan and several western European countries.

During the past year, the new International Nuclear Analysis program was established at the Laboratory by the DOE's Office of Nonproliferation and National Security to monitor the worldwide use and disposition of nuclear materials. This program functions as a single stop for information on nuclear reactor fuels and the nuclear materials produced as byproducts from nuclear power and research reactor operations. Data are submitted by all U.S. facilities that use and produce nuclear materials. Each of the research and power reactors worldwide is profiled with regularly updated operational histories, inventories, and projections of future operations. We also analyze production processes associated with special nuclear materials destined for weapons.

Export Control

The Laboratory has expanded its support of efforts to stem the supply of sensitive nuclear technology to proliferant nuclear programs. The DOE Proliferation Information Networked System (PINS), which was developed mainly at Los Alamos and Sandia, is supported by all the national security laboratories. PINS now provides nearly instant, secure electronic communication between the national laboratories and DOE headquarters. It is used to help regulate the supply of sensitive nuclear commodities, whether exported from the U.S. or retransferred from intermediates. Review of the full range of prospective sales is now done rapidly to facilitate approval of legitimate sales. Retrospective searches of the patterns of sales are also used to find systematic problems and ensure that U.S. export-control policies conform to the specifications of federal law and the Code of Federal Regulations.

Computer Workstation for Nonproliferation Analysts

We have developed a new information management system, called Watson, for use by an analyst of proliferation activites. Watson was designed to reduce operational costs and to allow a user to browse many data sources. It can access, store, and manipulate text, geographic data, and images. A geographic viewer lets an analyst recenter, resize, do range-bearing measurements, and coordinate displays. Following data retrieval, Watson provides for analysis and publication.

Arms Control Policy Support and Nuclear Material Control

Our traditional arms-control activities include providing analytical and technical support to treaty negotiators and developing equipment to monitor compliance. In a major new thrust, we are assembling a Laboratory-wide network of expertise to support the government in its interactions with weapon scientists and institutions in the states of the former Soviet Union. The goal is to help speed weapon dismantlement and defense conversion and

to build confidence between the U.S. and the new republics.

Our most recent priorities follow from the January 1994 Clinton–Yeltsin summit. At that meeting, the two leaders called for prevention of proliferation and, in particular, a transparent and irreversible process for removing fissile material from weapons.

Transparency of Weapon Dismantlement and Nuclear Material Storage

With the drawdown of Russian and U.S. weapons mandated by the START treaty and the withdrawal of tactical weapons from Europe, there is concern over the control of nuclear weapons and secure storage of the nuclear materials from dismantled weapons. In the absence of any formal treaty agreements, transparency measures are being pursued to provide insight and increase confidence in dismantlement activities and nuclear material control. Such measures can include declarations of weapons and material quantities and the purpose and capacity of nuclear facilities plus visits to nuclear facilities and inspection techniques.

The President's nonproliferation policy, announced in September 1993, calls for the U.S. to place excess nuclear materials from dismantled nuclear weapons under international monitoring and to seek a global ban on the production of fissile materials for weapons purposes. We have provided technical assistance to the DOE during the drafting of position papers, leading to U.S. policy on these issues.

In a March 1994 meeting between Energy Secretary Hazel O'Leary and a Russian delegation, it was agreed to begin inspections with reciprocal visits to nuclear material storage facilities of the two countries before the end of 1995. In a joint working group meeting in May, the sides agreed to conduct visits to plutonium storage sites in each country, with reciprocal inspections to begin by the end of the year. We have been involved in choosing and evaluating potential nuclear-materials measurement techniques and in assessing the sensitivity of sharing unclassified or classified information with the Russians, if necessary, to carry out inspections.

LLNL's interactions with the states of the former Soviet Union, and particularly the Russian Federation, expanded this year. Much of the expansion results from the Laboratory's continuing strong support of Laboratory-to-Institute collaborations with the scientific community in the states of the former Soviet Union. Today, scientists from 42 institutes, primarily in Russia and Ukraine, are funded on more than 150 projects involving all of LLNL's directorates. The State Department encouraged expansion of this activity to include scientists from other former Soviet states. In support, LLNL led a delegation of experts to the Republic of Kazakhstan and Belarus to begin establishing a Lab-to-Institute program.

We are involved in four other bilateral activities with the former Soviet Union. The Industrial Partnering Program, aimed at improving the industrial base of the former Soviet Union, involves all the DOE laboratories, scientists from the former Soviet Union, and U.S. industries. To assist the Russians in developing technologies for the marketplace, we hosted an entrepreneurial workshop on turning advanced technologies into commercial joint ventures. We support the International Science and Technology Center in Moscow, which now has funding from the European Community and other major western countries. To prevent the theft or unauthorized use of Russian nuclear weapons, components, and nuclear materials, LLNL specialists are also working with our counterparts

Our interactions with states of the former Soviet Union expanded considerably this year. Natalia Zaitseva from Moscow State University and LLNL's Jim De Yoreo examine KDP crystals grown at Livermore as part of a Laboratory-to-Institute collaboration. Their rapid-growth technique won an R&D 100 award this year.

Opening meeting of the Conference on Disarmament held in Geneva, Switzerland, in January 1994. This forum involves 39 member countries plus observer states. LLNL Arms Control and Treaty Verification Program Leader, Bill Dunlop (back row, third from right), serves as science advisor to the DOE CTB delegation. Other people from the NAI program are contributing to the negotiations as technical experts on specific topics.

from Sandia, Los Alamos, and the Russian nuclear weapons laboratories.

The Nonproliferation Experiment

A Comprehensive Test Ban (CTB) treaty is being negotiated at the Conference on Disarmament in Geneva, Switzerland. One important issue in the CTB deliberations is how to distinguish nuclear explosions from nonnuclear ones and from earthquakes. In September 1993, LLNL conducted the Nonproliferation Experiment, which provided direct information on this topic. For the first time, we compared seismic and other signals from a large chemical explosion to nuclear explosions of similar yield, which had previously been conducted under similar geologic conditions. Our studies showed that most signals from these two types of explosions are similar, but close-in electromagnetic measurements differ in their onset and rise times. These results indicate that remote discrimination between some non-nuclear and nuclear explosions could be very difficult, that non-nuclear explosives could be used to calibrate discriminants between nuclear explosions and earthquakes, and that confidence-building measures could be instituted if close-in monitoring is permitted on large, announced chemical explosions.

Regional Arms Control

Three of our current projects are examining steps that could be taken as confidence-building measures in regional areas of tension or concern related to arms control. Our regional seismic monitoring provides information on ambiguous seismic events and assurance that nuclear testing is not occurring. Our project on regional fissile material control is developing a monitoring framework to assure that nuclear material is not being produced for weapons purposes. Our computer similations show that border monitoring using emplaced sensors can potentially allow disengagement of forces and provide increased warning times.

Nuclear Emergency Response

This part of the NAI program is concerned with technologies that can find and neutralize nuclear weapons in battlefield, terrorist, or other situations. We support many national response capabilities, coordinate the DOE Threat Credibility Assessment program, and oversee the emergency preparedness program for the Livermore site. Here, we focus on some of our most recent accomplishments.

Support for Dismantlement

We are providing several types of LLNL-developed emergency-response equipment and software to republics of the former Soviet Union. We recently sent a PC-based atmospheric dispersion model to Belarus and will transfer a mobile radiological assay laboratory to that country in 1995. In late 1994, we prepared two liquid-abrasive cutting tools for Russia. In each case, we provided translated training guides and manuals as well as the necessary transport equipment.

Assessing Illicit Nuclear Sales

Illicit and attempted sales of nuclear material are increasing, mainly overseas. At the request of the U.S. government, we help assess the credibility of sales offers, provide advice on safe handling of materials, and assist in analysis or characterization of any materials exchanged or seized in a sale activity. This role is built on our long-term responsibility for the Threat Credibility Assessment program, in which we determine the credibility of nuclear threats from terrorists or extortionists.

Counterproliferation

Our counterproliferation program develops “intelligent” methodologies for processing information to discover concealed purposes, considers potential responses to proliferants, and assesses the potential economic, political, and environmental consequences of each response. Our newest work is helping the DOD and others develop a

broad-based counterproliferation technology program.

A key facility for our work is the Conflict Simulation Laboratory, which has been supporting military projects for almost 20 years and is now being used for a variety of other projects as well. The adaptability of our computer simulations has made them increasingly useful for situations other than standard war scenarios. For example, the Army recently used our Urban Combat Computer Assisted Training Simulation to plan operations in Somalia and Bosnia. The scenario in both cases focused on operations in and near the major airports in Mogadishu and Sarajevo, where the terrain is both urban and rural. Simulations of law enforcement activities, fire fighting, and response to natural disasters are among the many other nondefense applications we are addressing.

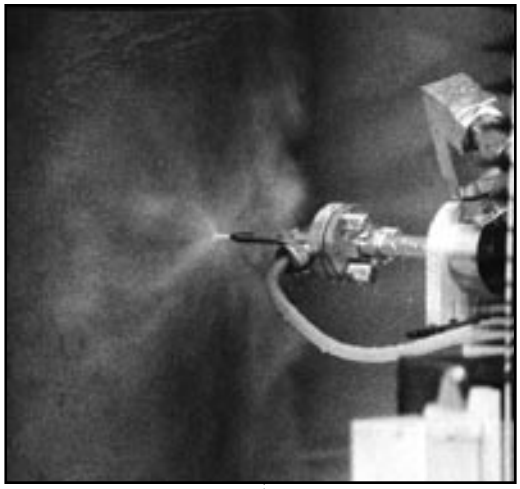
Virtual Commander

Advances in computer technology promise to revolutionize the way in which the modern military trains, plans, and fights. To be most effective, however, large-scale simulations have to calculate realistic behaviors for tens of thousands of entities and run in real time or better. Both issues pose challenges. Our Conflict Simulation Laboratory is solving this problem by partitioning a huge campaign among many computers. Communication among the computers will use standard protocols and network technology developed by the DOD's Advanced Research Project Agency.

The Virtual Commander (V-Com) project seeks to reduce player requirements substantially by allowing players to control battalions, not just platoons, in large simulated engagements. Plans are derived from minimal player input of high-level objectives, with the computer's analysis of the battlefield filling in the details. The bulk of V-Com's planning and decision making is done as the engagement progresses, based on current estimates of the situation. V-Com continually checks the validity of its plans and corrects them as necessary. V-Com offers a degree of fidelity in modeling responsive behavior that cannot be achieved in a conventional simulation. We have applied V-Com to several complex tasks, such as a mobile rocket artillery platoon, a firefighting brigade, and a search team.

Minefield Analysis

Our state-of-the-art battle simulation codes are used to determine optimum force levels. In one analysis, we used LLNL's combat simulation, the Joint Conflict Model, to study the use of anti-personnel mines to suppress fixed enemy artillery systems in support of a military campaign. We demonstrated that anti-personnel mines are credible and economical, especially when applied against an enemy that has located much of its artillery forces in hardened sites that are difficult to destroy. This type of simulation allows military planners to use low-cost, quantitative data to identify cost-effective solutions to difficult tactical problems.



One of two liquid abrasive cutters we provided to Russia to assist in their dismantlement efforts. The equipment operates in remote locations, and the cutter can be used safely on weapons containing high explosives.

Summary

A reduction of the international nuclear threat is one of the greatest challenges of this era. Serious dangers associated with nuclear proliferation, theft of nuclear weapons or fissile material, illicit sales, clandestine activities, and terrorism remain. Our highest priority is to support the nation's nuclear nonproliferation policy. We also continue to support U.S. arms-control activities in cooperation with nuclear inheritor states of the former Soviet Union. Some of our analysis techniques, including sensors and computer simulations, are finding important civilian applications in diverse areas, such as search and rescue, fire fighting and response to natural disasters, law-enforcement activities, and environmental protection.

For further information contact Robert T. Andrews (510) 422-5006 or George G. Staehle (510) 422-5006.